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PROCEDURE FOR

THE MEASUREMENT OF THE REFLECTANCE OF MANILA ROPE FIBER

FOR LIGHT OF WAVE LENGTH 500 MILLIMICRONS*

I. INTRODUCTION

Apparatus suitable for measuring the reflectance of Manila rope fiber at wave length 500 millimicrons, the angle of illumination being approximately 45° and the line of sight approximately perpendicular to sample and standard, is described and directions for preparing the sample and measuring it are given. The method described was incorporated in Federal Specification No. T-R-601 for Rope, Manila on March 7, 1933 by the Federal Specifications Board and is now applicable to the purchase of rope by all government departments.

II. APPARATUS

Figure A is a schematic drawing of the apparatus showing the relative position of the parts. The photometer (1) projects through its support (7) and has its axis perpendicular to the plane of the surfaces of sample and standard (2). The sample and standard are illuminated by the light source (3) with housing (4). The photometer support (7) also serves to shield the eyes of the observer from extraneous light. The photometer is rotated on its axis to bring the 0 to 90° quadrant of its graduated scale on top. Thus the 45° mark on the scale should be in the uppermost position. The photometer should be locked in this position.

The holder for sample and standard, (to be described below) is supported by the block (5) which is mounted on the base (6). It is essential not only that the light be incident upon the plane of the sample and standard at approximately 45° to the normal, but also that the block, to which the sample holder is affixed as shown at (13), be mounted on the base at an angle of 45° as shown. (Fig. A).

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Figure B is a detailed drawing of a holder for sample and standard showing a top view (10), a side view (11), and an end view (12). The mounting of the holder on the block is shown (13). The top view (10) shows the surface of sample (14) and standard (14'), a pivot (15) about which the holder can be rotated to interchange sample and standard in position, and the sample container (16). The side view (11) shows a coiled spring (17) for holding the standard in place and a flat spring (18), (see also (12)) for locking the holder in either of the two positions.

The following parts are required:

Martens photometer manufactured by Schmidt and Haensch, Berlin, Germany, and obtainable through Akatos Incorporated, 55 Van Dam Street, New York City; James G. Biddle, 1211 Arch Street, Philadelphia, Pennsylvania; or Eimer and Amend, 3rd Avenue and 18th Street, New York City.

Note:- Different models of the Martens photometer are available. These directions are written on the basis of the procedure necessary for one of the older models which is made with the calibrated scale fixed and the indicator movable. If any other model of the instrument is used, the design of the sample holder and the formula for calculation of results will have to be modified.

Wratten filter No. 75, cemented in B glass. Obtainable from Eastman Kodak Company, Rochester, New York.

1000-watt gas-filled mazda lamp.

Sample holder, as shown. Any instrument maker or machinst can construct this from the drawing. Brass is a suitable material. The sample container (16) and the holder for sample and standard (B) should be coated with a matte black shellac or lacquer.

Working standard white surface. This may be a piece of milk glass ground plane and matte on one side. This working standard should be of uniform reflectance, opaque, and of a permanent nature. The reflectance of the working standard should be accurately determined under conditions similar to those prevailing when the standard is in use, at wave length 500 millimicrons, relative to that of an accepted primary standard such as a freshly prepared standard white magnesium oxide surface. The advantage of this procedure is that different laboratories will be on a comparable and accurate basis. Such a determination made either in your own laboratory or by one specially equipped to do this work will obtain the proper reflectance factor (F) to be used with the working standard. It is recommended that two milk glass standards be obtained, one of which is to be used as a working standard and one to be set aside as a reserve standard to be used for calibration and checking the work-

ing standard. The working standard should be preserved in a suitable dust-proof container. Directions for preparing a magnesium oxide standard may be obtained upon request from the Bureau of Standards. However, reflectance factors for the working standard and reserve standard may be obtained at the time they are furnished and subsequent calibrations of the working standard need be made only by reference to the reserve standard. These standards may be obtained from Akatos Incorporated, 55 Van Dam Street, New York City, or Electrical Testing Laboratories, 80th Street and East End Avenue, New York City.

III. PREPARATION OF SAMPLE FOR MEASUREMENT

In order to obtain a representative sample all of the fibers in a cross section of the rope are taken. The fibers are cut into lengths of 1.5 to 2.5 millimeters. This may be done with sharp scissors or a sharp knife, but more conveniently with a meat cutter having a revolving disk blade. The cut fibers are thoroughly mixed, a portion placed in the cell of the sample container and alternately pressed and smoothed with a spatula until a flat surface level with the top of the container is obtained.

Fibers that are to be extracted before measurement are extracted in a soxhlet extraction apparatus for 2 hours with petroleum ether, allowed to air dry over night, and placed in the cell for measurement the following day.

IV. MEASUREMENT OF THE SAMPLE

Looking down into the photometer with the sample and standard in place in the holder and the light on, the observer sees a circular field half of which is illuminated by light coming from the standard and half by light from the sample. If the photometer has been mounted as directed, the dividing line between the two areas extends diagonally across the field bisecting the upper right and lower left hand quadrants.

The cap containing the colored filter is placed over the eyepiece of the photometer. The two areas in the field can now be made to match in brightness by rotating the photometer head and the position giving the match can be read from the graduated scale. All matches are made between 0 and 90° on the scale, though it is possible to make matches in all four quadrants. The effective wave length of the light for which the match is made depends upon the visual response of the observer, the spectral characteristics of the filter and light source used. For the normal observer, filter, and source specified it will be approximately 500 millimicrons. The more precise value obtainable by careful check of observer, filter, and source does not appear to be necessary for the measurement of Manila rope fibers.

The sample holder is first set so that the sample is in the upper left hand position, (position 1). The photometer head is adjusted until the brightness of the two fields is the same. The angle of match is recorded. Five such readings are obtained. The sample and working standard are then interchanged bringing the sample to the lower right hand position, (position 2). Ten readings are made and recorded. The sample and working standard are again interchanged, and, with the sample in position 1, five more readings are taken. The average of the readings obtained with the sample in position 1 is called θ_1 and the average with the sample in position 2, θ_2. Then the reflectance of the sample for light of wave length 500 millimicrons, under the conditions described, expressed as a percentage of that of magnesium oxide is obtained by the following formula:

$$\text{Reflectance (in per cent)} = 100\ F \cot. \theta_1 \tan. \theta_2$$

in which F is the factor for converting the reflectance of the working standard (under similar conditions) to that of magnesium oxide.

The cotangents and tangents of angles are given in engineering handbooks and in books on trigonometry. It is convenient to use the tables of logarithms. The computations may also be made with a special slide rule which is obtainable from Keuffel & Esser Company, Hoboken, New Jersey.

An example follows:

Observed θ_1	Observed θ_2
46.0°	32.2°
46.3	32.3
46.1	32.3
46.3	32.1
45.9	32.0
46.1	32.0
46.1	32.2
46.1	32.3
46.2	32.1
46.2	32.3
Average 46.13°	Average 32.18°

F for the working standard is 0.823 or log (0.823 x 100) = 1.9154

and log tangent θ_2 is 9.7988 - 10, log cotangent θ_1 = 9.9829 - 10.

Adding the three logarithms

$$\begin{array}{r} 1.9154 \\ 9.9829 - 10 \\ 9.7988 - 10 \\ \hline 21.6971 - 20 \end{array} = 1.6971$$

The antilog of this number is 49.9 which is the percentage of the light of wave length 500 millimicrons reflected by the sample relative to that which would be reflected under the same conditions by magnesium oxide.

A considerable number of measurements indicate that the result of a single measurement is correct, on an average, to within ± 1. for a fiber having a reflectance value of 50%. This information will be a guide in determining the significance of a measured difference.

It is desirable that these measurements, as in the case of all photometric work, be made in a darkened room.

With the aid of a small reading lens, fastened in place above the scale on the photometer, the observer may estimate, with ease, to tenths of a degree.

V. PRECAUTIONS

The rope fibers should be cut into lengths from 1.5 to 2.5 millimeters. Fibers of greater length usually result in lower reflectance values.

The surface to be measured should be made as flat as possible and should lie in the plane of the surface of the standard. Unevenness will produce shadows which will lower the reflectance value.

The surface of the sample should not be disturbed by jarring, etc. during measurement.

The working standard should be kept clean. A very slight film of dust or dirt will appreciably alter the result. Milk glass standards may be satisfactorily cleaned with an ordinary art gum eraser. They should be washed with soap and distilled water and rinsed with alcohol occasionally.

References.

In order to obtain reliable measurements with this apparatus it is necessary to understand the device and to be sure it is properly set up, properly calibrated, and used. The following references may be helpful to the technologist who is not experienced in colorimetry:

Martens, Über ein neues Polarizationsphotometer. Physikalische Zeitschrift vol. 1, pp. 299-303 (1900). (Original description of Martens photometer, in german).

Appel, Wm. D. A method for measuring the color of textiles. American Dyestuff Reporter vol. 17, pp. 29-34, 49-54 (1928). (Description of apparatus and method similar to that proposed. If measurements at wave lengths other than 500 millimicrons are to be made the more elaborate apparatus described in this paper should be built. Working drawings of this apparatus are obtainable from the Textile Section, Bureau of Standards, Washington, D.C.

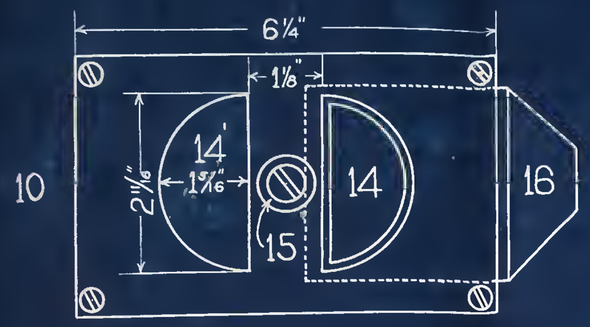
McNicholas, H. J. Equipment for routine spectral transmission and reflection measurements. Bureau of Standards Journal of Research RP 30 vol. 1, pp. 793-857, January 1928. (Valuable information pertinent to the use of the Martens photometer is given in this paper.)

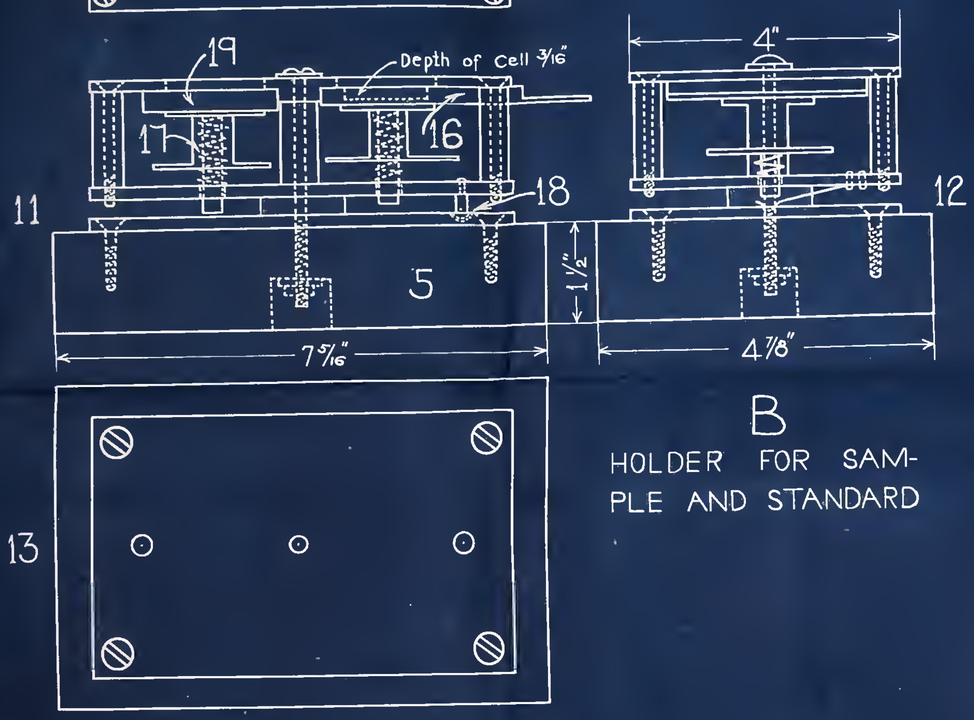
McNicholas, H. J. Absolute methods in reflectometry Bureau of Standards Journal of Research, RP 3 vol. 1, pp. 29-73, July, 1928. (Theoretical discussion of reflectometry with examples).

Report of the Optical Society of America Committee on Spectrophotometry, vol. 10, pp. 169-241, February, 1925. (General information).

Report of the Optical Society of America Committee on Colorimetry for 1920-1921. Journal of the Optical Society of America and Review of Scientific Instruments vol. 6, pp. 527-596, August 1922. (General information).

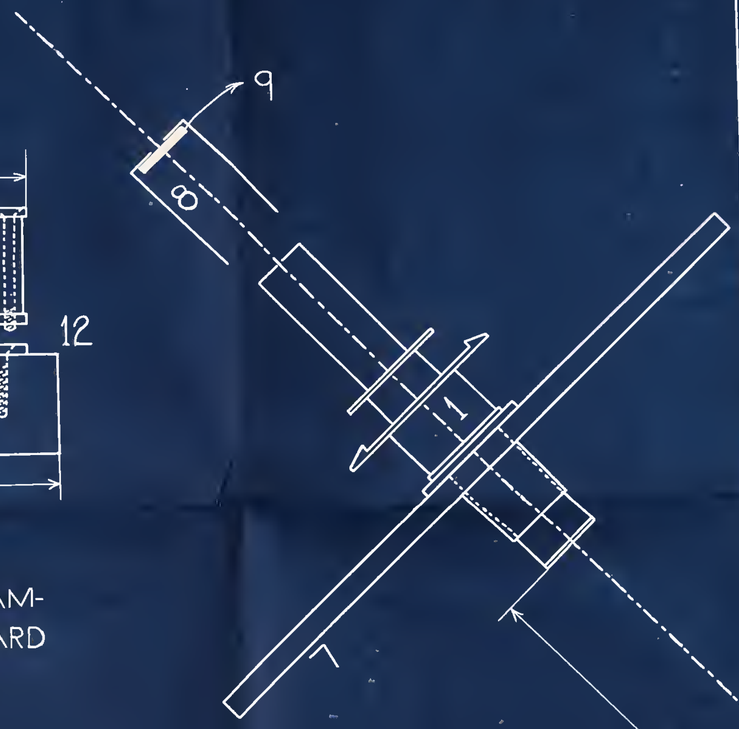
MARTENS PHOTOMETER ASSEMBLY FOR REFLECTION MEASUREMENT

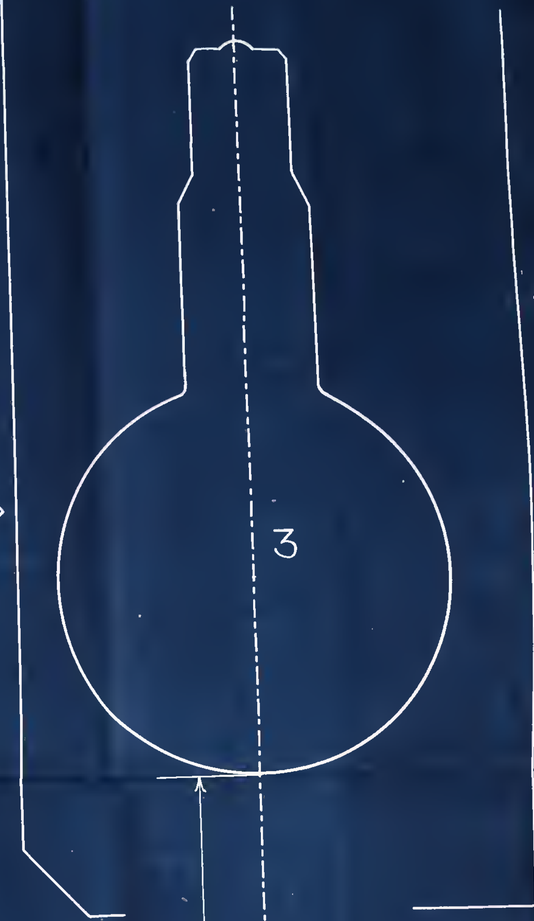




B

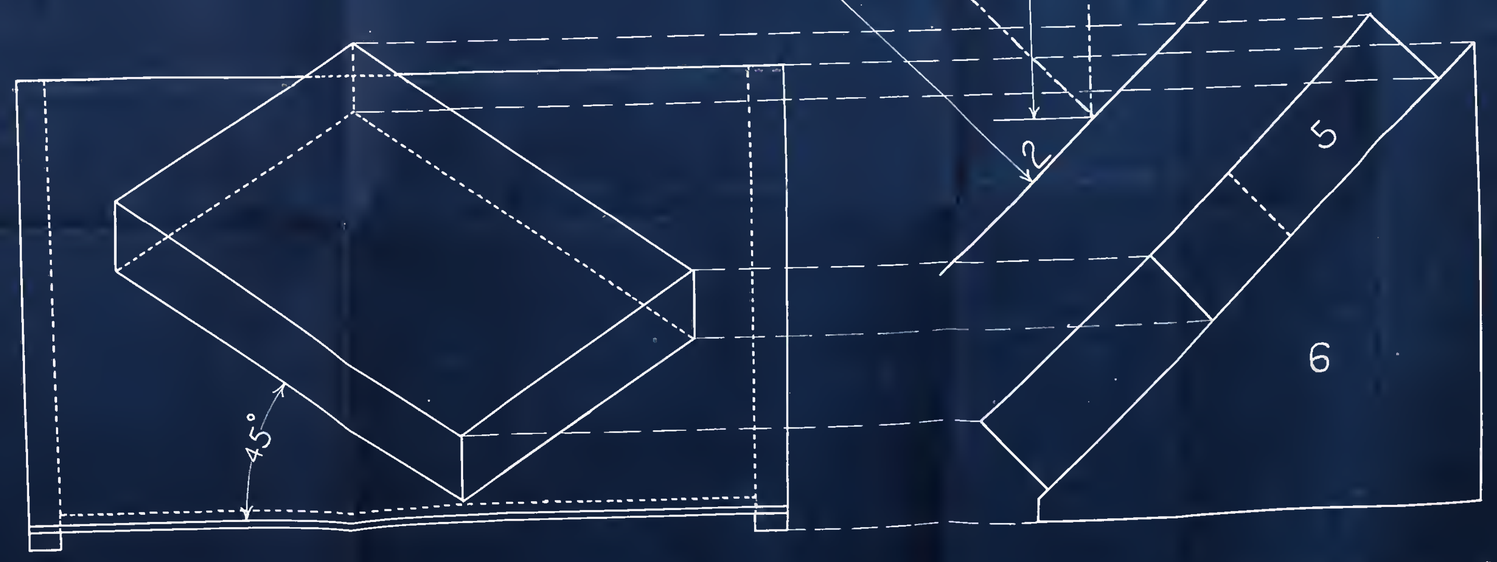
HOLDER FOR SAMPLE AND STANDARD





A

DIAGRAM SHOWING RELATIVE POSITION OF PHOTOMETER LIGHT SOURCE AND HOLDER FOR SAMPLE AND STANDARD



0 1" 2" 3" 4"
SCALE

1_Photometer
2_Plane of Sample and Standard
3_Light Source
4_Light Housing
5_Block
6_Base for Mounting Block
7_Light Shield
8_Filter Cap
9_Filter
10_Top View of Holder
11_Side View with Constr. Indicated
12_End View
13_Base of Holder
14_Sample Field
14'_Standard Field
15_Pivot
16_Sample Container
17_Spring
18_Locking Clamp
19_Standard

Bureau of Standards
Textile Section
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